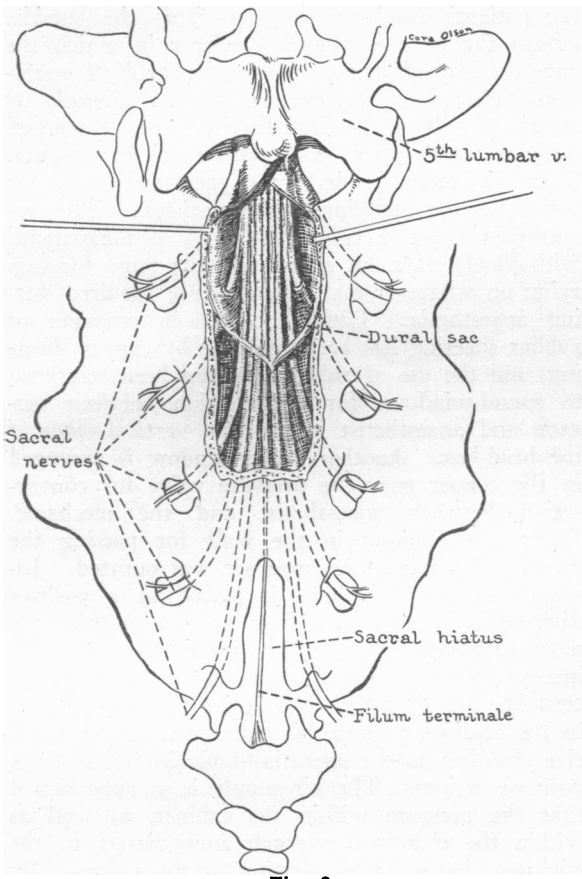

Fig. 3
Showing relation of dural sac to the sacral canal, nerves and sacral ligament

nausea and two lost consciousness for several minutes. One patient developed a definite psychosis following the injection which lasted about thirty minutes. Transient sensations of faintness and forceful and increased heart beat were occasionally seen. In no case were delayed or prolonged after-effects observed, and in none was there indication of paralysis of the anesthetized nerves after the general effects of the anesthesia had receded.

Caudal anesthesia gives an excellent relaxation of the lower ureter, and permits the manipulation of ureteral stone; in some cases several large ureteral catheters may be readily inserted to the site of the stone without causing the patient discomfort. Occasionally there is relaxation of the lower ureteral segment and spasm of the upper ureter which causes an impassable angulation.

Sacral anesthesia is simply and easily carried out. It causes very little discomfort to the patient, gives a satisfactory working anesthesia, and rarely produces undesirable after-effects.

Provisions of Sheppard-Towner Act Rejected by Five States—"During the summer the State of Maine, through the action of Governor Baxter and his Council, and the State of Louisiana, through the action of its Legislature, rejected the provisions of the Sheppard-Towner Act. Thus, five States have made definite rejection of Federal aid offered through that Act. Most of the State Legislatures will meet in January, 1923, and final action will be taken by those bodies on this matter in the States where the Legislatures have not already accepted or rejected the provisions of the Federal maternity and infancy law, through which the national Government offers financial aid to States which will carry out a program approved by a Government board."—A. M. A. Bulletin.

INTRATRACHEAL INSUFFLATION ANAESTHESIA *

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One of the greatest dangers of intrathoracic operations is the occurrence of pneumothorax as soon as the pleural cavity is opened. This, when limited to one side, while not fatal, always causes more or less serious respiratory embarrassment. When both cavities are opened the result is generally fatal. As it not infrequently occurs in operations upon one side of the thorax that the opposite lung is more or less incapacitated as a result of injury or disease, the desirability of avoiding the serious consequences of pneumothorax has long been appreciated.

The word *pneumothorax* was coined in 1803 by Itard, a French physician. The condition it describes barred for practically one hundred years the chest cavity to the knife. Modern thoracic surgery dates from 1896, when Quénu first made known the idea of restoring in pneumothorax artificially by differential air pressure the disturbed equilibrium of the lung, and Tuffier advocated the use of insufflation for the performance without pneumothorax of operations requiring the incision of the pleura. Quénu's apparatus was constructed on the lines of a diver's helmet in which the head of the patient was placed with a sponge saturated in chloroform. The air in the helmet was compressed and the pleural cavity opened. Tuffier introduced a narrow, slightly curved copper tube into the larynx and trachea. Matas of New Orleans was the first in the United States to become interested in thoracic surgery. He introduced the *Feel-O-Dwyer* type of apparatus for artificial respiration. The anaesthetic was given by means of a funnel attached to a T-tube. The main tube was introduced into the larynx and trachea. In 1898 Parham of New Orleans used the Matas apparatus in performing a resection for tumor of the bony wall of the chest—the first thoracic operation of record in this country. In 1903 the Sauerbruch cabinet was invented; and 1904 marks the real beginning of thoracic surgery by the transpleural route. For its performance Sauerbruch had built a chamber of about five hundred cubic feet contents, constructed of iron and glass, inside of which the operation is performed. Over the opened pleural cavity the air pressure is reduced below atmospheric pressure, while the patient, whose head is passed through an opening in the wall, breathes in atmospheric pressure. In quick succession, chambers were built in Berlin, Cologne, Vienna, St. Petersburg, and other places in Europe. Size of the chambers averages about six hundred cubic feet contents; the largest one at Vienna contains about 750 cubic feet. Their height is usually seven feet six inches.

The reverse proposition was also taken up by Sauerbruch, and after him Peterson, and Engelken constructed positive differential pressure cabinets, Peterson of wood and Engelken of iron and glass,

* Presented to the Pacific Coast Association of Anesthetists, May 16, 1922.

boxes of about fifty cubic feet contents, into which the head of the patient is passed through an opening in the side wall. The inside air pressure is then raised above atmospheric pressure. The patient breathes compressed air, while outside of the cabinet the pleural cavity is opened in atmospheric pressure. The anaesthetic in operations with these chambers and cabinets is applied in the ordinary way—with ordinary face mask and ether by the drop method. The anaesthetist frequently became partially anaesthetized. The construction of these chambers and cabinets was such that the surgeon could not see the head of the patient, and the anaesthetist could not follow the operation. Telephones were then installed, but the open air-pipes connecting the pump cylinder with the chamber or the cabinet made of the latter practically a part of the pump cylinder, in which the clicking of the valves, the hissing noise of the air in the air-pipes, and the boiling of the air through the water valve combined to make such a noise that the telephone was inaudible. Ventilation was deficient, the air being renewed only once in ten or fifteen minutes. The anaesthetist's attention was taken from the patient to regulate the pressure and other duties, which should have been done by others.

These inconveniences were avoided in the positive differential pressure apparatus of Bauer. The head of the patient is enclosed in an air-tight box about five cubic feet contents, in which the air is changed from four to five times every minute. The anaesthetic is applied by mask in the ordinary way. Openings are provided in the side of the box, through which the hands and arms of the anaesthetist are introduced, and then made air-tight by means of rubber gloves fastened inside of the box. It is thus from the outside that the anaesthetist applies the anaesthetic and manipulates the head of the patient, which he sees before him below a pane of glass. In 1907 Green and Janeway had constructed a positive pressure apparatus of the Bauer type, but modified and improved as to the valve action and mechanical appliances for artificial respiration during anaesthesia. In 1908 Willy Meyer's Positive Pressure Cabinet appeared. A cabinet of about eighty cubic feet contents, large enough for two anaesthetists, was built of wire screens and made air-tight from the inside by means of a bag of rubber sheeting, through which conversation between surgeon and anaesthetist can be carried on. The anaesthetists within are placed in a current of fresh air; the exhaust is near the head of the patient, so that the vapors of the narcotic are absorbed by the patient only. The air is changed once every minute. Outside, against one side of the cabinet and projecting far out from the same, a pyramidal box was placed opening inward and closed in front by a rubber collar through which the head of the patient is passed. The bottom of this head-box is horizontal, and serves to carry an adjustable support for the patient's head, offering besides room for instruments, etc. The top of the box pitches downward and consists of a large pane of glass, below which the patient's head can be seen from the outside. Above the pane is placed a mirror in which the anaesthetists, glancing up, see the field of operation reflected. The cabinet has an air-lock by means of which the anaesthetists can be reached without interruption of the difference in pressure. There is room inside for oxygen-tanks and for apparatus for applying the anaesthetic. The anaesthetists have access to the head of the patient, with plenty of room all around the same for carrying on whatever manipulations are required during anaesthesia. Lately, the inside covering of rubber sheeting has been replaced by copper sheeting, and the use of rubber sheeting been restricted to sound-windows for conversation between surgeon and anaesthetist in the two vertical sides of the head-box. Another sound-window is arranged in the copper near the pressure valve for conversation between anaesthetist and the mechanic. Later, the opening in the wall for passing the patient's head into the open air was omitted. Instead, the patient's head is placed in a positive differential pressure cabinet erected within the negative chamber. The size of the latter has been increased to approximately one thousand cubic feet contents (16 x 8 x 8). When the patient's head is in the positive cabinet, his body rests in the negative chamber on the operating-table in front of the positive cabinet. The air supply is so apportioned that the pressure within the cabinet, as well as within the chamber, responds immediately to the slightest change in the setting of the valves. By opening or closing these valves differences in pressure are produced, the extent of which is read on the gauge. Using the gauge as guide, the valve can, therefore, be handled in such a way that the pressure rises and falls between limits determined by the surgeon.

Reduction in the size of cabinets from six hundred to fifty cubic feet contents, and from fifty to five cubic feet proved that cabinets could be dispensed with. Its place has been taken by the mask and intubation tubes and an apparatus forcing ether vapor through the same. Of the mask type are the apparatus of Brat-Schmieden and of Tiegel. In both the drop method is used, in combination with an oxygen tank, the oxygen stream carrying the anaesthetic to the lung. The pressure in the lung is maintained by expiring against either a spring valve (Schmieden) or a water column (Tiegel). The intubation type is the apparatus of Kuhn. A tube is introduced into the trachea and compressed air is mixed with ether vapor blown through the same into the lung.

In 1908 experiments to overcome the deleterious effects of pneumothorax in operations upon the thoracic viscera were started. The experiments mainly followed two plans:

First. To increase the air pressure within the bronchial tubes and thus prevent a collapse of the lung when the negative pressure on the surface of the lung is removed by opening and admitting air to the pleura.

Second. To diminish the atmospheric pressure on the exterior of the lung when the chest is

opened, while maintaining the normal pressure of the air entering the trachea.

Experiments with the first method have generally been carried out by means of a snugly fitting tracheal cannula or intubation tube and some form of an air-pump or bellows.

Experiments by the second method—by placing the animal's body below the neck in an hermetically sealed chamber from which a certain amount of air has been drawn. This was the Sauerbruch cabinet, the then most satisfactory negative pressure apparatus. When sufficient air is withdrawn to render the negative pressure equal to 10 or 12 cm. of mercury it was found that in opening both pleural cavities the lungs did not collapse, but respiration continued without the slightest embarrassment.

F. T. Murphy of Boston has devised an airtight helmet which incloses the patient's head and neck, and in which the air pressure is increased and maintained by water displacement. Since that time experimental work has been towards employment of methods of positive intratracheal pressure rather than those utilizing negative pressure as in the Sauerbruch cabinet. Then came the Tiegel positive pressure apparatus and next came a portable positive pressure cabinet of Janeway and Green. Many others worked along these lines, but it remained for Auer and Meltzer to perfect and popularize the intratracheal anaesthesia. This is the method of introducing in the trachea a flexible tube, the diameter of which is much smaller than the lumen of the trachea, and they established the facts that pulmonary ventilation might be maintained by a constant stream of air or oxygen, under definite pressure being blown in the trachea and which returns along the space between the tube and the wall of the trachea and escapes through the mouth and nose. This insured the proper oxygenation of the blood, inflation of the lungs, favored the continuance of cardiovascular circulation, and permitted the induction of narcosis by means of a volatile anaesthetic. The result is an ideal anaesthesia because the dosage can be accurately adjusted, and by this means adequate and efficient respiration can be carried on, when, for any reason, the normal respiratory mechanism is embarrassed or fails completely. The embarrassment caused by spasm of the glottis, accumulation of mucus in the pharynx, and the dropping backward of the tongue are entirely avoided, and the demonstrated impossibility of foreign substance present in the mouth or pharynx entering the trachea or bronchi.

The Auer-Meltzer is a comparatively simple apparatus, and it abolishes the cumbersome uncertain appliances of the past and opens the thorax to the progress of surgery. The work of Auer and Meltzer, Elsberg, Flint and others has proved that intratracheal anaesthesia is not only a successful solution of an important phase of intrathoracic surgery, but is a safe adventure.

In 1912 Saxton Pope of San Francisco constructed an apparatus involving the Auer and Meltzer theory. Its principal features are compactness, a means of the accurate regulation of the proportion of ether and air given, electric heating to volatilize the ether and a pressure and safety valve attachments. This apparatus has been used for intratracheal anaesthesia with the most satisfying results.

To develop the technique of this form of anaesthesia I gave a series of intratracheal anaesthetics in 1913 to forty-two cases in general surgery. Since then I have had for intracheal anaesthesia the following cases: Mediastinal tumor, 4; carcinoma of mouth, 1; carcinoma of larynx, 3; carcinoma of tongue, 3; carcinoma of esophagus, 4; sarcoma of jaw, 1; carcinoma of cheek, 1; carcinoma of lip, 2; tracheoplasty, 2; diaphragmatic hernia, 1.

The technique for intratracheal anaesthesia is as follows: The patient is thoroughly anaesthetized by the gas and ether sequence. Buccal or nasal anaesthesia is continued to maintain anaesthesia during the stage of introducing the laryngeal catheter. The side-mouth gag is inserted. The first and second finger of the right hand are put well down the throat, the epiglottis located and pushed well forward; then the introducer loaded with the disconnected catheter (a No. 21 or No. 22 French catheter) is passed along the finger into the rima glottidis. As soon as the catheter is in the trachea you realize the fact by the hissing of the air in the tube on respiration of the patient, or by coughing of the patient, who is lightly anaesthetized. This is not an easy procedure, as the catheter may be inserted in the esophagus more readily than into the trachea. When the tube is in place it is then pushed down a distance of 25 or 30 centimeters from the teeth, and the introducer slipped off. Then the connection is made with the machine for intratracheal anaesthesia. A far better method of introducing the catheter is by means of the laryngoscope.

Some of the patients complained of sore throat after recovery from the anaesthesia, some had laryngitis, but this was due more to the unsuccessful attempts at intubation than the irritation of the tube in place. No case developed pneumonia. The tracheal tube is left in until breathing is good and coughing warns us of the return of the laryngeal reflex. At the end of an operation the patient can be roused within two to five minutes by giving straight air.

Continuing the history of intratracheal anaesthesia, we find the group of cases in which intratracheal anaesthesia has been found to be so highly advantageous is very limited, and that the Meltzer method has been supplanted by the pharyngeal method of Connell. Pharyngeal insufflation has supplanted intratracheal in all operations, even those requiring positive pressure for intratracheal work—except in such cases where collapse of the trachea is threatened—and eliminates the most serious complication of intratracheal anaesthesia, oedema of the epiglottis.

The apparatus illustrated is a modification of Pope's original apparatus, and following the suggestions of Dr. Sheldon, a member of the house staff, I now possess a practically noiseless motor which he devised.

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